GREEN AIRCRAFT SOLUTION SPACES

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Green Aircraft Problem Space[s]

- **The Emissions Issues**:
  - NOX
  - CO2
  - Water/Cirrus
- **Fuel Burn**
  - Reducing fuel burn A LONG TERM,Expensive, PARTIAL [only] Approach/solution
  - Therefore primarily a cost reduction issue

NOx Reduction[s]

- NOx can be reduced MUCH via clever combustor design. In HSR we worked such as “lean Burn, quick quench” etc and reduced NOx significantly.That was then, before we had the combustor physics/codes we now have [Thanx to CTR etc.].….Serious [replaceable/”drop-in”] combustor [re]Design

Water/Cirrus Reductions

- Water addition above the Tropopause [above some 27K-30K ft] is warming/reflective of outgoing radiation. Water below 27K ft is cooling,reflects incident solar radiation
- Therefore - Fly/Cruise Below 27K ft. Not a major ATC issue, just “Different.” If design the A/C for this little-to-no fuel burn impacts [downsize the wing]
- Utilize Circulation Control for takeoff to downsize wing & Greatly increase Airport Productivity [multiple takeoffs on same runway], utilize at cruise for ride quality “In the Weather”

CO_2 Reduction

- Use of “Drop-in” Biofuels sourced from Halophytes, Algae and Cyanobacteria [utilize waste lands, waste/saline/salt water, MASSIVE Capacity] SOLVES CO_2. The plants take up the CO_2, some is sequestered, rest goes back into atmosphere, better than a closed cycle. NREL estimates Biofuel cost by 2020 ish at $1.00/Gal.

Fuel Burn Reductions - Why?

- Trying to reduce A/C emissions via fuel burn reductions requires new aircraft [very expensive and time-consuming] and would NOT be Curative, only a Partial Solution. The solution spaces just discussed are FAR more Efficacious in terms of cost, time & effectiveness
- The projected cost reductions for Biofuels make Fuel Burn Reductions less interesting than otherwise, but, for those interested, LaRC has work ongoing under Grant to VPI et al on a Machine that should reduce Fuel Burn some 85% - An in-house N+3 M~.9 A/C

Technology to Double CTOL L/D [~ 40++] Incorporating Weight/Propulsion/Emissions/Vortex Hazard Solutions

- The basic Enabler is full span Truss-Braced Wings, courtesy of CFD
- Huge wing weight Red.
- Thin wing and unsweep, Natural Laminar Flow, wing Cf Red.
- DDL red. Via either Wing-Tip Engines, C-Tips or Wing-grid [~ 30%+ DDL red.]
- Alternative DDL red. Is Folding Span extensions, double Span, 75% DDL red.,,large span/small chord wing, even more Laminar Flow

Double CTOL L/D - Cont.

- **Fuselage Cf Red. Via red. Length, greater height [red. Wetted area, height for Truss attachment], riblets, Marlin nose to age boundary layer**
- **Engines Buried in Fuselage Base/boundary layer inlets and Goldschmied Shrouds, 20% to 25% in "Propulsion Efficiency", thrust vectoring for control/no Empannage or wing nacelles, major acoustics benefits**
- **Chutes and Automatic Landing Sys. for gear weight Red. , BNNT structural/skin material[s]**
- **Also, red. Wake vortex via DDL, red. Weight and enabled control vortex generation/vortex systems**
- **Circulation Control for takeoff [200ft TO roll] and cruise ride quality to solve emissions [fly below 27k ft. for H2O], Biofuels**

Thus Far [technology option[s] and effort-wise] , the L/D is in the mid-high 40's
IF add Fuselage re-laminarization just downstream of the forward door [due to radome, pitot tubes, windshield wipers etc. nose of fuselage is turbulent] and use the ingested air for turbulent slot injection D.R. in the Fuselage/wing Interference wedge can attain L/D in the high 50's to 60's…….

Double CTOL L/D - Concluded

- Advanced Engines - Aspirated Compressors, Wave Rotors, Endothermic Fuel Cooling, Recuperators/tion
- Conops - Wing Tips [half the span] fold for Gate [“80 M. Box”], deploy/Lock outer & inner region Trusses before takeoff
- Serious “Load Alleviation”, “VPI Truss Joints”

WAG Performance Benefits

- L/D > 40 [into the 60's]
- 70%< Fuel Burn [up to 85%+]
- + 25% Propulsion Efficiency
- ~ 30% DRY WEIGHT REDUCTION [~ 70%+ for BNNT's]
- ~ 250' TAKE OFF ROLL
- EMISSIONS "SOLVED" [BIOFUELS, FLY BELOW 27K FT]

Summary

- The Major, most effective/efficient/timely A/C Emissions Reduction Approaches are not related to A/C Drag etc. per se.
- Aircraft/ usual vehicle performance approaches to Green are in general long term, expensive and partial
- There are several long term/Revolutionary Energetics Approaches which could “Solve” Green, these include LENR, some 4,000 times Chemical Energy Density, neg. emissions, theory under evaluation